Regional Variability and Predictability in the Upper Ocean

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LONG-TERM GOALS

Our long-term objectives are to understand the dynamics of upper ocean physical processes and air-sea exchange and to see that understanding integrated into operational Navy strategies. Of particular interest is understanding the variability of the upper ocean on vertical scales from tens of centimeters to hundreds of meters, and on horizontal scales of meters to tens of kilometers, and the role that spatial-temporal variability in the atmospheric forcing plays in setting those scales.

OBJECTIVES

Our objective for this project is to improve our understanding of variability in the upper ocean encountered by battle groups and to determine if local observations will lead to improved predictions that can be used to the advantage of the Navy.

APPROACH

Our approach is to pursue our research objectives in large part by participation in fleet exercises. These exercises might include SHAREM (Ship ASW Readiness Effectiveness Measuring) Programs, MIREM (Mine Warfare Readiness Effectiveness Measuring) Programs or similar exercises focusing on the performance of Navy systems in the upper ocean and/or atmospheric boundary layer. We plan to conduct enhanced environmental monitoring during exercises. We will place small, non-intrusive instruments on ships operating in the exercise region to collect time series of the surface meteorological forcing and upper ocean structure. We will also design and fabricate easily deployable/recoverable buoys equipped with meteorological sensors and upper ocean temperature, salinity, optical and current sensors. The marine boundary layer observations will provide complete and highly accurate air-sea flux measurements.

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These supplemental non-intrusive instruments would provide high quality in-situ measurements that would later be combined with all other data collected in stride during the exercise in an environmental reconstruction during retrospective analysis of the exercise. This retrospective analysis would focus on quantifying the environmental variability seen in the upper ocean, examining the predictability of this variability and exploring how the environment may have impacted performance of operational systems used in the exercise. We will couple our work with that of the Surface Warfare Development Group (SWDG) as they plan, carry out and analyze results from exercises.

WORK COMPLETED

SECNAV Oceanographic Research Chairs and ONR/Institution Scholars are asked to develop scientific collaborations with other Navy and Marine Corps activities; advise ONR on policy and procedures for support of high quality oceanographic science and technology; participate in ONR Department Reviews; help identify promising science and technology opportunities in oceanographic sciences; and participate in the synthesis of recently completed ONR initiatives. Additionally, Chairs and Scholars may be asked to represent the Navy and ONR science and technology efforts to the Fleet, other agencies, and general audiences.

A large part of our effort during the first year went towards becoming familiar with the ONR and Navy groups and activities that we would be working with during the next three years. This included travel to various ONR and Navy meetings and workshops, as well as providing scientific briefings to WHOI visitors.

During the second year of this project, we participated in GOMEX 99-2/ MIREM-9 that took place on the Texas Shelf south of Port Aransas. Our objective for this project was to assist the Surface Warfare Development Group and the Office of Naval Research in observing, documenting and improving our understanding of the marine environment encountered the during GOMEX 99-2/ MIREM 9 advanced sensors testing and operational exercises. We deployed an oceanographic buoy to monitor surface winds as well as the vertical temperature and salinity (and thus sound speed) profiles during the exercise. We collected additional meteorological measurements with ASIMET instruments mounted on the bow mast of the R/V Gyre.

Albert Fischer, a graduate student supported on this project, finished his dissertation on an analysis of data collected during the ONR Arabian Sea project studying the open ocean oceanic response to monsoonal forcing. Tom Farrar is entering the Joint Progam in September 2000. He will be supervised by R. Weller and supported by this project.

Jason Gobat graduated from the Joint Program in May 2000. He is now working as a Post-Doc on this project. He has been developing a real-time buoy data system that uses acoustic, inductive, radio and satellite telemetry. The buoy system will telemeter wind, wave, current, temperature, salinity and diver visibility in real-time. We were preparing to deploy this buoy system off the coast of South Korea in support of MIREM-15. However, we were unable to secure logistical support from the Navy for this operation and are now considering future deployment options.

RESULTS

The results from the MIREM-9/GOMEX 99-2 buoy deployment were written up in a report that was submitted to SWDG. These results were also presented in briefings to SWDG, ONR and MIW-METOC. We are planning a test of the real-time buoy system for November 2000.

IMPACT/APPLICATIONS

We hosted a meeting between five Navy personnel from the Surface Warfare Development Group (SWGD) and ONR PI's located at WHOI. This meeting allowed for the exchange of information between the two groups. The attendees explored areas of overlapping interests and possible collaborations. Common interests were noted in the following areas: data visualization and synthesis, coastal oceanography, bottom boundary layers including sediment transport and resuspension, precision navigation methods, search pattern logic, acoustic propagation, surface waves and wave impacts, the marine atmospheric boundary layer, marine mammals, impacts of biologics on acoustics, small (meters) to mesoscale (10's to 100's of kilometers) variability in T, S, and velocity, the impact of fronts and other mesoscale structure on acoustic propagation, air-sea interaction, predictability of the upper ocean, and AUVs and low-power, high-accuracy instrumentation.

However, for maximum benefit to flow to the Navy it is critical that WHOI PI's learn how to distill knowledge and methodology to fit Navy needs. This distillation may take the form of tactical decision aids or of environmental classifications of use to the Navy operators (for example, not just by season but by environments characterized by different physical processes and thus by different but characteristic variability in time and space). WHOI PI participation in exercises in partnership with SWDG should be encouraged, as it is seen to be an effective means to educate WHOI PI's about Navy needs. In addition, briefings such as that at WHOI on 2/17/2000 and workshops should be pursued as they establish contacts, educate both sides about capabilities and needs, and maintain the dialog.

Longer-term Action items identified at the meeting include:

1) The convergence of WHOI and SWDG interests in common geographic regions such as the Arabian Sea, East China Sea, Korean coastal waters is noted, as are the benefits to both SWDG and WHOI that would result from exchange of information and knowledge about these regions. WHOI PI's would gain from access to environmental data from these regions, and WHOI research in these regions would be used to aid the planning of exercises and the development of environmentally responsive, tactical guidelines for operations in those regions. An ongoing dialog is needed so that WHOI and SWDG interact early enough in the exercise planning cycle (12 months prior to exercise) for both sides to derive maximum benefit.

2) WHOI knowledge of the environment, its variability, and their impacts on acoustic and other systems could be used to refine publications and procedures developed by SWDG for the fleet. The means for using this knowledge to improve Navy guidelines and procedures for coping with, and benefiting from, the environment should be developed.

TRANSITIONS

We have continued to successfully interact with the operational navy and ONR advanced sensor groups through the MIREM program. We learned from the Navy and ONR investigators what sort of

environmental factors play a role in performance of various systems and operations. SWDG learned what sorts of observations and analysis we can assist with in future operations. This effort is paving the way for our participation in future exercises and at a more effective level. One potential transition at the completion of this project might be the adoption of an environmental buoy, or "Battle Space Buoy", that the Navy could deploy in stride, like the Battle Space Profiler, to monitor the battle space environment in real-time during operational activities.

RELATED PROJECTS

A related project is the ONR Innovative Platforms For Upper Ocean Research (Award Number N00014-97-1-0158). The technological objectives for this project are to develop the engineering tools to model, design, build, deploy, and retrieve a reliable horizontal submerged array. This will improve our ability to fully visualize, measure, and thus understand the physical processes active in the upper ocean in three dimensions on scales from meters to one kilometer. This effort is in collaboration with M. Grosenbaugh and W. Paul from the Applied Ocean Physics and Engineering Department at WHOI.

A second related project is the ONR Coupled Boundary Layers Air-Sea Transfer (CBLAST) DRI. This project is just spinning up with field work scheduled for 2001 and 2002.

Table. Chronology of project related travel and activities.

28 October 1999	S. Anderson and R. Weller attend GOMEX Cold Wash briefing at ONR.
4 November 1999	S. Anderson and R. Weller Visit SWDG to give briefing on MIREM Enhanced Environmental Monitoring.
22-25 February 2000	S. Anderson attends and presents briefing at MIW-METOC workshop in Corpus Christi
7 March 2000	S. Anderson and R. Weller host meeting between WHOI scientists and personnel from SWGD.
10-14 March 2000	R. Weller chaired the Code 32 Board of Visitors